

Introduction

How do we effectively rehabilitate land degraded by biological invasions? Many riparian areas on the Yellowstone River have converted to dense Russian olive stands, reducing agricultural and ecological value of these lands.



Pre-removal of Russian olive May 2011



Post-removal of Russian olive May 2011



Russian olive trees cut with tree shear to ground level and immediately sprayed with 3:1 basal bark oil , triclopyr mix .

Objective

To determine if restoration is necessary after Russian olive removal and then to establish the effectiveness of four restoration strategies.

Methods

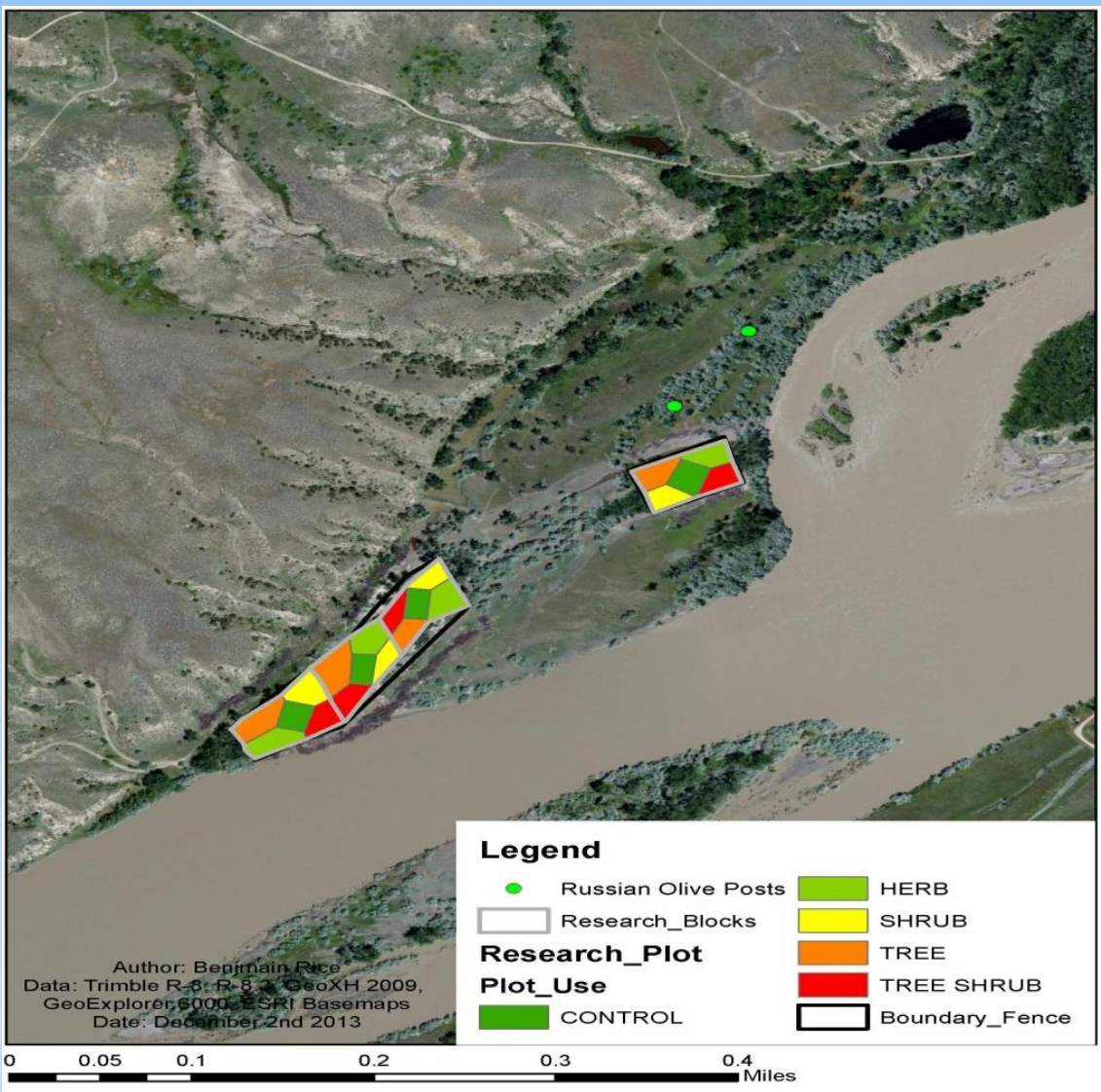
Four replicate 0.5 ha blocks

5 treatments:

1. C - no revegetation
2. H – seeded herbaceous layer
3. S – herbaceous layer with planted shrubs
4. T – herbaceous layer with planted trees
5. TS – herbaceous layer with trees and shrubs

Basal and Canopy cover:

- 2010 - pre-removal Russian olive
- 2012, 2013, 2014, 2015 post removal



Location of study sites at USDA-ARS Fort Keogh Livestock and Range Research Laboratory

Herbaceous seeding mix:

•Grasses: prairie cordgrass, slender wheatgrass, switchgrass, western wheatgrass

•Forbs: American vetch, blue flax, Canadian milkvetch, Maximilian sunflower, yellow prairie coneflower, purple prairie clover, Rocky Mountain beeplant, Rocky Mountain penstemon, white prairie clover, yarrow

Woody species planted:

•Trees: boxelder, green ash, narrowleaf cottonwood, plains cottonwood

•Shrubs: silver buffaloberry, chokecherry, golden currant, Woods’ rose

Species Diversity:

Every species that germinated in each plot was recorded in 2012-2015.

Results

•Annual brome cover was highest in 2010 (32%±3%), lowest in 2012 (15%±3%), and similar in years 2013-2015 (avg. 23%±3%).

•Non-native forb cover was over 3 times lower in 2015 (11±2.5%) compared to the highest cover in 2013 (37±2.5%).

•In 2015, the T treatment plots had the lowest non-native forb cover (4±6%) and the TS treatment had the highest cover (20±6%).

•Seeded herbaceous species established with cover 8 times higher in 2015 (44±2%) than 2012 (5.5±2%).

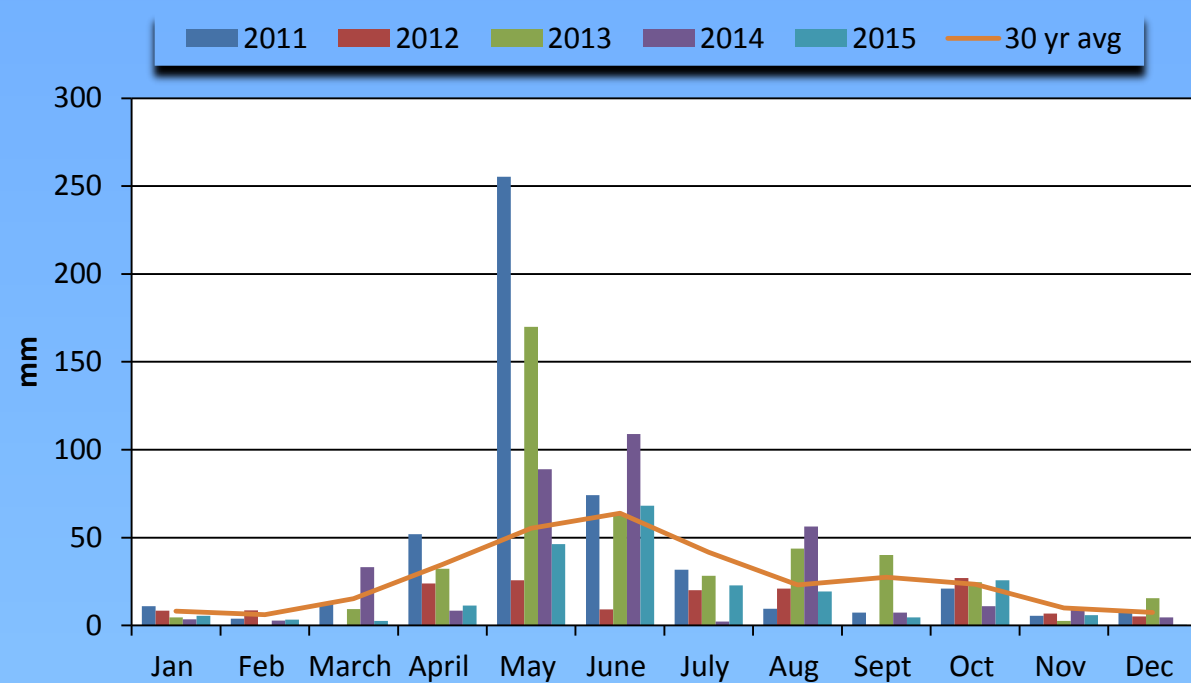
Functional Group % Cover by Year

Group (%)	Year					SEM ²
	2010 ¹	2012	2013	2014	2015	
Native Perennial Grass	6 ^d	7 ^d	16 ^c	27 ^b	43 ^a	2.4
P<0.0001						
Native Forb	0 ^d	9 ^{ab}	11 ^a	7 ^{bc}	5 ^c	1.2
P<0.0001						
Annual Bromes	32 ^a	15 ^c	22 ^{bc}	25 ^{ab}	22 ^{bc}	3.1
P=0.008						
Seeded grasses	6 ^d	5 ^d	14 ^c	26 ^b	42 ^a	2.3
P<0.0001						
Seeded forbs	0 ^c	0.5 ^{bc}	1.5 ^{ab}	2.1 ^a	2.2 ^a	0.4
P=0.0007						
Seeded species	6 ^d	6 ^d	16 ^c	28 ^b	44 ^a	2.4
P<0.0001						

abcdMeans within rows followed by the same letter do not differ (P < 0.05).

¹Data collected pre-removal. ²SEM = Standard Error of the Mean.

Annual Precipitation 2011-2015



•137 total species were observed at the research site from 2012-2015

•15 native perennial grasses, 20 native perennial forbs, 16 native annual forbs and 11 native woody species revegetated the site naturally

•9 of the 13 seeded species germinated in over 70% of the plots (prairie cordgrass, slender wheatgrass, western wheatgrass, blue flax, Canadian milkvetch, Maximilian sunflower, yellow prairie coneflower, Rocky Mountain beeplant, and yarrow)

•Some species were slow to establish, switchgrass was first observed in one plot in 2014, in 2015 it was present in 50% of the plots



Block 1 Tree seeding 5-28-14

Vegetation change from 2012-2015



Block 1 shrub seeding 8-8-2012



Block 1 shrub seeding 8-20-2013



Block 1 shrub seeding 5-28-14



Block 1 shrub seeding 7-30-15

Implications

•After four years since active restoration, the herbaceous seeding with planted shrubs had the lowest cover of annual bromes (14±3%) and highest cover of seeded herbaceous species (33±2%).

•New native species are continuing to establish at the site.

•The site is monitored yearly as Russian olive seedlings are still germinating .

•Seeded herbaceous species cover is continuing to increase over time but it is too early to make a definitive conclusion on the impact in reducing non-native species invasions.

•This site will continue to be monitored yearly for an indefinite number of years and used as a long-term research and demonstration area.



Burning of Russian olive slash piles 1-19-16